Dairy

Perspectives in Liquid Process Analytics

4

News

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Leading Process Analytics

Effluent Monitoring and Process Control
in Milk Processing via Turbidity Measurement

Continuous turbidity measurement of wastewater is used in a large Scandinavian milk processing facility to control production processes and to monitor final effluent discharge. Automatic sensor cleaning generates savings in maintenance costs.

Dairy industry in Scandinavia

The Scandinavian countries are by tradition closely tied to dairying. Many market leaders, including our customers, are to be found in that region. Globalization as well as environmental-friendly production methods strongly characterize the milk industry generally. It is therefore not surprising that in milk processing, wastewater disposal issues are of growing importance and that operational processes are subject to continuous optimization.

Wastewater as a cost factor

The volume of wastewater produced by a milk-processing plant is a cost factor not to be underestimated. Optimization of production processes and production flow are of central importance. Wastewater management is today applied in order to be able to react quickly to faulty production cycles. Consequently, various parameters are subject to online measurement. The measurements serve not only to control the plant processes but also to monitor the effluent being released from the plant into sewers or receiving waters, since in the event of excessive pollution loads this can result in correspondingly high effluent discharge levies.

Control parameters for wastewater

In the dairy industry, the chemical oxygen demand (COD) is regarded as the sum parameter. Continuous analytic determination of the COD of a wastewater is however very time-consuming. Therefore, alternative online analysis uses the optical characteristics of the wastewater samples

METTLER TOLEDO

through application of absorption or turbidity measurement systems. A combination of both systems enables calculation of the COD value and optimization of the plant control. Product losses and effluent discharge tariffs as cost factors are closely connected. With the help of wastewater analytics, product losses can be determined relatively exactly. Via known COD values for individual products, a product loss can be calculated on the basis of the COD value of the wastewater.

METTLER TOLEDO solution

We were able to convince our customer to employ turbidity and not conductivity as the appropriate measurement parameter, since conductivity measurements can be falsified by the changing acidity, and also in case of emergency, turbidity measurement requires less time to do. The competing products tested (max. temperature 60 °C, (140 °F) were inadequate, since at operating temperatures between 81 °C, (178 °F) and 90 °C, (194 °F) only sensors made of stainless steel can be considered for use. The following components go together to form a full measuring system:

- Turbidity sensor InPro 8100 of stainless steel for backward scattered light
- Immersion housing InDip 550 for open tanks
- Transmitter Trb 8300
- Cleaning and calibration system EasyClean 100 (EC100)

Five identical systems were installed, one at each wastewater outlet. The systems have been in operation since August 2006 to the full satisfaction of the customer.

Reduced Maintenance

To ensure data reliability, measurements and completion of protocols are always carried by two employees together. The METTLER TOLEDO systems made it possible to greatly reduce the number of inspection rounds, as the sensors were flushed automatically via the EC 100 for 30 seconds every two to three hours. Actual measurement is made directly after the flushing process. Maintenance work proper is now only necessary once a year.

Customer benefit

- Control of COD values via turbidity measurements reduces product losses
- Specific control of effluent discharge saves high additional charges
- Automatic sensor cleaning with EasyClean 100 reduces maintenance costs

Advanced technology of InPro 8100 (Fig. 1)

The single optical fiber sensor InPro 8100 provides a wide linear measuring range – also there where competing absorbance probes have long reached their saturation limits. The use of backscattered light technology enables a sensor design with uniform, unbroken surface structure, so that the formation of deposits is minimized and the sensor able to be thoroughly cleaned. Therefore, InPro 8100 sensors fulfill the high expectations placed on optical sensors with respect to hygiene and low maintenance effort. Trouble-free transfer of measurement values is made possible by the use of fiber optic technology which also allows compact sensor design.

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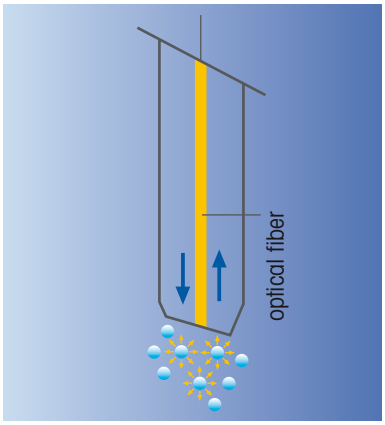
Fig.1: InPro 8100 with backscattered light technology.



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Detecting Turbidity in Dairy Processes with InPro 8600

The quality of recycled process water and the degree of clarification of whey are two important characteristics for assessing the operational performance of recycling and membrane filtration plants. A novel inline turbidity measurement system provides valuable service in continuously monitoring these two processes to detect trace amounts of suspended matter.

Turbidity measurement: applications and benefits

– Process water

There is enormous potential for cost savings in the area of recycling and preparation of process water – particularly in plants in which water accrues, so to say, as a "byproduct". Such is the case, for example, during manufacture of more or less solid products (milk or whey powders, and cheese). The water accumulates as condensate following evaporation processes, or in the form of permeate during membrane filtration.

In water recycling processes, in line turbidity measurements offer the possibility to continuously monitor the water quality relative to the concentration of undissolved milk components present. This information is then made use of to determine whether the various processing stages are functioning efficiently, und how the cleaned water can be reused or, in line with regulations, even be used at all. Insufficient purification performance is immediately recognized and costs arising from the inappropriate use of contaminated water avoided.

– Whey processes

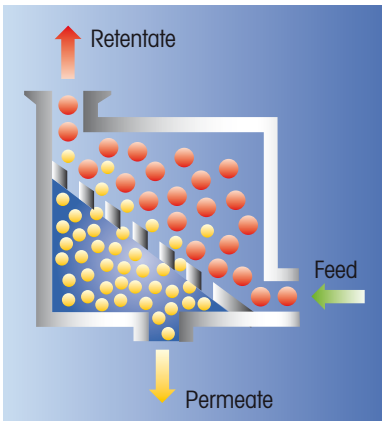
During the concentration of whey components by means of membrane filtration, the clarity of the retentate or of the permeate, depending on intended use, plays an important role relative to the productivity of the separation plant. For instance in nanofiltration and ultra- or reverse osmosis, the turbidity level of the incoming liquid must be kept at a very minimum in order to prevent premature blinding or even damage of the expensive membrane modules. Excessive turbidity is signaled mainly to protect the expensive membrane filtration module, and consequently to ensure sustained productivity. During whey protein concentration, any turbidity of the retentate indicates undesirable protein denaturation.

– CIP solutions and BOD/COD reduction

Additional applications for turbidity measurements are to be found in the recovery of spent CIP solutions or as a supporting measurement during reduction of the Biological Oxygen Demand / Chemical Oxygen Demand of wastewaters.

The new turbidity sensor InPro 8600

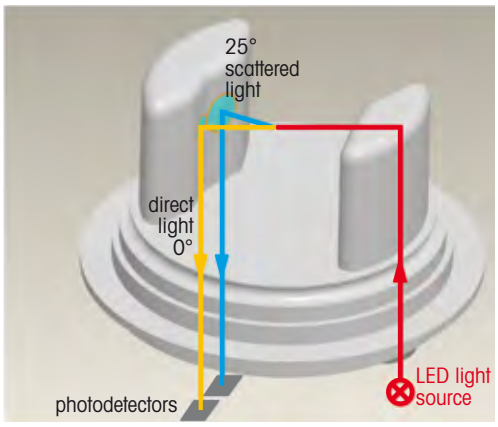
For these measurement tasks, METTLER TOLEDO has developed a turbidity sensor,



The principles of membrane filtration are that the liquid to be filtered passes over the membrane at high velocity. Depending on the membrane pore size, different sizes of molecules are able to pass through the membrane. The feed product is split into two streams:

- Permeate containing water and particles smaller than the membrane pores.
- Retentate containing water and particles larger than the membrane pores.

Fig. 1: Scattered light sensor head with sapphire optics.



compelling for its measurement precision, easy operation and the incorporation of an innovative, cost-saving sensor management for communication with a standard PDA via Bluetooth.

The scattered light sensor head (Fig.1), provides the basis for the extremely low detection limit of 0.025 ppm (0.01 FTU). The sapphire optical windows are naturally fully compatible with CIP applications and a new sealing process makes replacement of polymer seals redundant. The light source is a long-life LED, eliminating costs for frequent bulb change. The sensor can be easily mounted in a Tuchenhagen VARINLINE® Access Unit and is ready for use within minutes (Fig. 2). The sanitary design is EHEDG-certified and guarantees safe, contamination-free operation.

The electronics with Bluetooth interface are integrated in the stainless steel IP 65 sensor enclosure (Fig.3). Several sensors can be managed via a single PDA wireless network, so that the costs arising from installation and use of separate transmitters completely fall away. The PDA is employed solely for application-specific sensor configuration and for servicing purposes. For instance, this enables the 4-20 mA ouput, also installed in a splash-proof enclosure, to be gauged for continuous transfer of the measured values. Alternatively to sensor management via PDA, a user software for laptops and PCs is also available. All in all a truly winning concept!

Benefits of the InPro 8600 at a glance

Reduced investment and installation costs
A wireless configuration tool faciliates installation and start-up of the system. The compact design of the sensor enables the installation in minimum space.

Improved process quality
Sapphire optics and certified hygienic design gurarantee reliability and process safety.

Intelligent sensor management
Factory calibration and sensor recognition enable easy and fast instrument configuration.

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Fig. 2: Tuchenhagen VARINLINE®
Access Unit; flange for pipe installation.

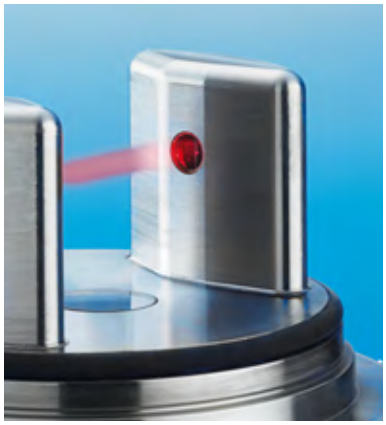
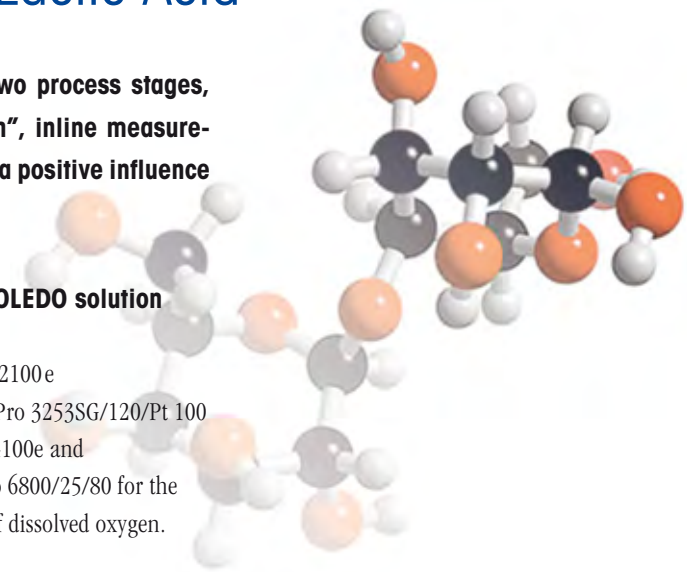


Fig. 3: IP65 housing
with Bluetooth interface and mA-output.

Inline Monitoring and Control of pH and O_2 during the Production of Lactic Acid



Over and above straightforward monitoring of the two process stages, "Preparation of nutrient solution" and "Fermentation", inline measurement of the pH and dissolved oxygen parameters has a positive influence on yield and quality of the final lactate product.

Lactose permeate production

A large French company specialized in the production of cheese and in the processing of the byproducts, including permeate, the most widely used and most suitable substrate for the production of yeast for the food industry recently started on a series of tests for optimization of the different stages involved in fermentation. Anaerobic glycolysis (fermentation), without which no cheese can ever be made, is carried out under the exclusion of molecular oxygen, converting glucose into lactic acid in a two-stage process. The balance equation for this fermentation process is:

$$\underset{\text{Glucose}}{C_6H_{12}O_6} \xrightarrow{\text{NAD}} \underset{\text{Lactate}}{2CH_3CHOHCOOH}$$

A strain of pure yeast together with different milk constituents were fermented in a 100 liter pilot vessel and the influence of the critical parameter values of pH and dissolved oxygen analyzed. This enabled to determine the optimal value for both parameters as exactly as possible for each production step.

InPro 3253 SG.

Measurement of pH and DO

One of the most important requirements for an optimal test run was the guaranteed availability of reliable, continuous inline measurement of pH and DO so that during the fermentation process it would be possible to react in realtime and to adapt external parameters accordingly.

InPro 6800.

The METTLER TOLEDO solution consisted of:

- Transmitter pH 2100 e
- pH electrode InPro 3253SG/120/Pt 100
- TransmitterO_2-4100e and
- O_2-Sensor InPro 6800/25/80 for the measurement of dissolved oxygen.

Precision, reliability and safety

The electrode InPro 3253 SG prevents any blockage or fouling of the membrane surface. During the various phases of fermentation, all risk of contamination, particularly by bacteria, must be avoided. By maintaining a slightly acidic pH value and through sterilization of the measurement apparatus and fermentation media, the growth of any type of bacteria is surpressed.

The oxygen sensor InPro 6800 with its sanitary concept (sterilizability, autoclavability, and surface roughness N5) combined with high measurement precision, more than fulfills these requirements. Use of these two measurement loops guarantees precision, reliability and safety.

Higher yield and improved quality

By being able to achieve highly precise oxygen measurements, it was possible to greatly improve both the production performance and the quality of the end product. The tests have shown that the very best results are achieved at DO values of between 0 und 10%. It was possible to exactly determine the amount of dissolved oxygen, and this in direct correlation to the amount of substrate fed to the process during the reaction stage. After this pilot stage, the established values were extrapolated for immediate application in the production with larger scale fermenters (10 000 and 15 000 liters). The pH and DO measurement loops from METTLER TOLEDO enable the proper sequence of the various fermentation stages to be controlled. Due to the many options offered by the METTLER TOLEDO transmitters, a next step will be automation of the oxygen feed rate to the reactors on the basis of the limit values determined during the pilot test phase. This will allow comprehensive, realtime monitoring of the fermentation process as well as economic feed of additional substrate.

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www.mt.com/pro-pH

Open Fieldbus Protocols support
Asset Management and Plant Maintenance

Open fieldbus technology like HART®, FOUNDATION™ Fieldbus and PROFIBUS® enables the full use of METTLER TOLEDO functional advantages on digital communication:

- improved resolution of measured values,
- intelligent sensor diagnostics and instrument parameter settings
- comfortable instrument configuration out of a central station,
- higher level of process data to improve the plant conditions,
- availability of additional process values to be easily integrated into the control system

Our intelligent analytical instruments are equipped with electronic device descriptions (DD) for various process instrument configuration software tools.

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METTLER TOLEDO recommends

- Transmitters for pH/ORP, dissolved oxygen and conductivity

Two transmitter lines for integration in HART®, FOUNDATION™ Fieldbus and PROFIBUS® PA networks.

- EasyClean 400

The cleaning and calibration system EC 400 for an easy integration in FOUNDATION™ Fieldbus and PROFIBUS® PA networks.

- ISM technology

Integration of sensor diagnostic information into the process control environment – "sensor wear monitor" and "adaptive calibration timer" for optimal maintenance planning.

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